

RTCA Special Committee 209 / EUROCAE WG49

ATCRBS / Mode S Transponder MOPS Maintenance

Joint Meeting #12

**Malakoff
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Further input on remaining comments on ED-73C

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SUMMARY

This Working Paper proposes inputs to close some of the remaining open issues raised by EADS.

The following tables contain those issues that may have been discussed during Meeting #11, but where there was a decision to have further discussion during Meeting #12.

ED-73C paragraph	ED-73C Text	EADS comment	Eurocontrol analysis reviewed by WG49 subgroup teleconference	WG49-SC209 agreement
5.4.5.2.a.(2)	<p>STEP 1 - Pulse Level Tolerances, Mode A/C/S All- Call (Paragraph 3.9.2 a.) Using a Mode A interrogation followed by a 1.6-μs P4 pulse at its nominal position, interrogate at the standard rate and at an RF signal level 10 dB above MTL.</p> <p>Vary the level of the P4 pulse between -10 dB and 0 dB with respect to P3. Measure and record :</p> <p>(1) the highest level of P4 relative to P3 at which 90% Mode A replies occur.</p> <p>(2) the lowest level of P4 relative to P3 at which</p>	<p>Mode S acceptance: The Mode S reply rate should be 90% instead of 99% to match with the previous definition of P4 non-acceptance conditions.</p>	<p>OK for 90% as it is defined in 3.9.1 and because it is not an interrogation using P6 for which 99% is defined above MTL+3dB</p> <p>Proposed action:</p> <ol style="list-style-type: none"> 1. in ED-73 5.4.5.2 a (2) replace 99% by 90% 2. DO-181D 2.3.2.5 does not specify the percent – the meeting to consider the addition of the 90% criteria to determine the levels 3. + correct typo error add a t before he in the 2nd paragraph 	<p>SC209/WG49 agrees that there needs to be a % value, but will need to research whether it is 90% or 99%.</p> <p>To be discussed next meeting</p>

ED73 states :

3.2.4 Sensitivity and Dynamic Range

- The Minimum Triggering Level (MTL) for Mode A/C and Mode A/C/S All-Call interrogations, having equal amplitude P1 and P3 pulses and P2 not detected shall be -73 dBm, ± 4 dB.
- The MTL for Mode S (P6 type) interrogations shall be -74 dBm, ± 3 dB.
- The reply ratio shall be at least 99% for all Mode S (P6 type) interrogations at signal levels between MTL+3dB and -21 dBm.
- The reply ratio shall not be more than 10% for interrogations at signal levels equal to or below -81 dBm.
- The variation of the MTL between Mode A and Mode C interrogations shall not exceed 1 dB.
- The reply ratio shall be at least 90% for Mode A/C and Mode A/C/S All-Call interrogations between MTL + 3 dB and -21 dBm.
- The spurious Mode A/C reply ratio resulting from low level Mode-S interrogation shall be no more than:
 - an average of 1% in the input interrogation signal range between -81dBm and the Mode S MTL, and
 - a maximum of 3% at any given amplitude in the input interrogation signal range between -81dBm and the Mode S MTL.

3.9.2 Pulse Level Tolerances

- Mode A/C/S All-Call interrogations
If the equipment receives a valid Mode A/C interrogation at any signal level from MTL+1dB to -21 dBm, followed by a long P4 pulse:
 - (1) it shall accept the interrogation as a Mode A/C/S All-Call interrogation if the received amplitude of the long P4 is greater than the amplitude of P3 minus 1 dB;
 - (2) it shall accept the interrogation as a Mode A/C interrogation if the received amplitude of a long P4 is less than the amplitude of P3 minus 6 dB.

It is therefore proposed to modify ED-73 as follows:

Using a Mode A interrogation followed by a 1.6- μ s P4 pulse at its nominal position, interrogate at the standard rate and at an RF signal level 10 dB above MTL.

Vary the level of the P4 pulse between -10 dB and 0 dB with respect to P3.

Measure and record :

(1) the highest level of P4 relative to P3 at which 90% Mode A replies occur.

(2) the lowest level of P4 relative to P3 at which 99% 90% Mode S replies occur.

Repeat the test at RF signal levels -60, -40 and -21 dBm.

Repeat the tests using a Mode C interrogation.

DO-181 states the same thing in 2.2.2.4:

2.2.2.4 Sensitivity and Dynamic Range

Given an interrogation that requires a reply, the minimum triggering level (MTL) is defined as the minimum input power level that results in a 90 percent reply ratio if the interrogation signal has all nominal pulse spacings and widths and if the replies are the correct replies assigned to the interrogation format.

a. The MTL for ATCRBS and ATCRBS/Mode S All-Call interrogations **shall** be -73 dBm \pm 4 dB.

b. The MTL for Mode S format (P6 type) interrogations **shall** be -74 dBm \pm 3 dB.

c. The reply ratio **shall** be at least 99 percent for all Mode S (P6 type) interrogations between MTL +3 dB and -21 dBm.

d. The reply ratio **shall** not be more than 10 percent for interrogations at signal levels below -81 dBm.

2 Although receiver characteristics for frequency and bandwidth in subparagraphs §2.2.2.1 through §2.2.2.4 are specified in terms of ATCRBS interrogations and replies, the specifications are adequate for both ATCRBS and Mode S interrogations.

e. The variation of the MTL between ATCRBS Mode A and Mode C interrogations **shall** not exceed 1 dB.

f. The reply ratio **shall** be at least 90 percent for ATCRBS and ATCRBS/Mode S All-Call interrogations between MTL and -21 dBm.

2.2.6.1.1 ATCRBS/Mode S All-Call

If the equipment receives a valid ATCRBS interrogation at any signal level from MTL +1 dB to -21 dBm followed by a 1.6 microsecond pulse in the P4 position:

a. it **shall** accept the interrogation as an ATCRBS/Mode S All-Call interrogation if the received amplitude of P4 is above the amplitude of P3 minus 1 dB;

b. it **shall** accept the interrogation as an ATCRBS interrogation if the received amplitude of P4 is below the amplitude of P3 minus 6 dB.

The test in 2.3.2.4 & 2.4.2.5 may be changed as follows:

2.4.2.5 Pulse Decoder Characteristics (§2.2.6)

Equipment Required:

ATC Test Set with P4 Capability (TIC T-50-3A/4B, or equivalent).

Wide Band Dual Channel Oscilloscope (HP 1710B, or equivalent).

Mode S Transponder Test Set (Required for Steps 8 through 10).

Measurement Procedure:

Step 1 Pulse Level Tolerances, ATCRBS/Mode S All-Call (§2.2.6.1.1)

Connect the equipment as shown in Figure 2-26. Interrogate at the standard rate and at an input level 10 dB above MTL. Use an ATCRBS Mode A interrogation

followed by a 1.6-microsecond P4 pulse in its nominal position. Vary the level of the P4 pulse between -10 and 0 dB with respect to P3. Verify the changeover from ATCRBS to Mode S replies at the relative P4 levels specified in §2.2.6.1.1.a and b when more than 90% of the replies are Mode S or ATCRBS. Repeat the test at input signal levels -60, -40 and -21 dBm. Repeat the tests using an ATCRBS Mode C interrogation.

5.4.6.2. Steps 7A/B/C/D/E/ F/ G/H/I/	Set the Master Test Set to generate a standard (i.e., -60 dBm) UF4, UF5, Mode A and Mode C interrogations and verify that the Mode A code and Altitude/ Mode C information provided in the transponder replies is correct. Repeat the procedure given in preceding paragraphs as needed to verify performance of the transponder on both top and bottom channels of diversity transponder.	The Master Test Set is required to be Mode A/ModeC/UF04/UF05 in the second repetition of each test. This is wrong, it shall be the Slave Test Set.	Proposed action: Next meeting to verify and clarify whether it is the master or the slave test set. Same question for DO-181D 2.4.2.6 step 7	SC209/WG49 agrees that the reference to "Master" should be changed to "Slave" in the 2 nd paragraph after the Note in Steps 7A/B/C/D/E/F/G/H/I Further review of all these steps is needed
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To be reviewed during the meeting

5.5.8.3	Procedure #3 – CA Verification	CA=7 is not tested on Procedure #2. Therefore the reference to Procedure #2 (interrogation acceptance) is wrong. It should be to Procedure #7 (FS and VS test)	Procedure #2 or # 7 seem both a possible option. Proposed action: Meeting to decide what to do. In addition the CA procedure is very light and may need to be more detailed!	SC209/WG49 agrees that there is a need to review the testing of CA=7 for next meeting
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It is proposed to modify ED73 5.5.8.3 and DO181 2.5.4.3 as follows:

2.5.4.3 Procedure #3 Ca verification

A separate test sequence is not required. The following tests may be combined with the FS test in procedure #7, interrogation acceptance in Procedure #2 and whenever a squitter is encountered.

For level 1 transponder (2.2.14.4.6 & 2.2.18.2.8)

Do not provide airborne/ground information to the transponder
Interrogate the transponder with UF11 Mode S format
Verify that CA =0 in DF 11 replies and in acquisition squitter

For transponder with an automatic means to determine on-the-ground
Set the transponder airborne
Interrogate the transponder with UF11 Mode S format
Verify that CA =0 in DF 11 replies and in acquisition squitter
Set the transponder on the ground
Verify that CA=0 in acquisition squitter

For level 2 or above

Provide the minimum information to the transponder. If the transponder supports TCAS do not connect TCAS.

Do not provide information about ground status
Wait for no more Comm B broadcast (DR=0)
Interrogate the transponder with UF11 Mode S format
Verify that CA = 6 in DF 11 replies and acquisition squitters
Change the data-link capability report or the Aircraft Identification to generate a Comm-B broadcast (DR not equal to 0)
Verify that CA=7 in DF11 and acquisition squitters
Wait that the Comm-B broadcast disappears
Provide information in order set FS to 2 (alert airborne)
Verify that CA=7 in DF11 and acquisition squitters
Provide information in order set FS to 4 (alert & SPI)
Verify that CA=7 in DF11 and acquisition squitters
Provide information in order to set FS to 5 (SPI)
Verify that CA=7 in DF11 and acquisition squitters

Set the transponder to on-the-ground
Wait for no more Comm B broadcast (DR=0)
Verify that CA = 4 in acquisition squitters
Change the data-link capability report or the Aircraft Identification to generate a Comm-B broadcast (DR not equal to 0)
Verify that CA=7 in acquisition squitters
Wait that the Comm-B broadcast disappears
Provide information in order to set FS to 3 (alert on the ground)
Verify that CA=7 in DF11 and acquisition squitters
Provide information in order set FS to 4 (alert & SPI)
Verify that CA=7 in DF11 and acquisition squitters
Provide information in order to set FS to 5 (SPI)
Verify that CA=7 in DF11 and acquisition squitters

Set the transponder airborne
Wait for no more Comm B broadcast (DR=0)
Interrogate the transponder with UF11 Mode S format
Verify that CA = 5 in DF 11 replies and acquisition squitters
Change the data-link capability report or the Aircraft Identification to generate a Comm-B broadcast (DR not equal to 0)
Verify that CA=7 in DF11 and acquisition squitters
Wait that the Comm-B broadcast disappears
Provide information in order set FS to 2 (alert airborne)
Verify that CA=7 in DF11 and acquisition squitters
Provide information in order set FS to 4 (alert & SPI)
Verify that CA=7 in DF11 and acquisition squitters
Provide information in order to set FS to 5 (SPI)
Verify that CA=7 in DF11 and acquisition squitters
For transponder supporting TCAS
Provide TCAS information
Verify that CA=7 in DF11 and acquisition squitters

5.5.8.4.b.(1)	<p>PC Discrimination The interrogation patterns are: UF = 4, 5, 20, 21. PC = 0 and DI≠3 PC = 0 and DI=3 and LSS=1 and SIS=0 PC = 1 and DI=3, PC = 2, 3, 4, 5, 6, 7. Total number of patterns = 36. With the transponder not in non-selective lockout state, interrogate with all of the above patterns consecutively. Verify that, after the sequence, the non-selective lockout state does not exist.</p>	<p>PC=1 and DI=3 condition triggers the non-selective all-call lockout. Therefore it should be removed from the negative test conditions.</p>	<p>same test in DO-181D 2.5.4.4.2 a</p> <p>3.22.2.4 (Do181 2.2.18.2.4) non selective lockout and Figure 3-11 (Do-181 Fig 2-13) show that PC=1 triggers non-selective lockout whatever the value of DI. HOWEVER 3.18.4.26 (DO-1812.2.14.4.28) PC protocol states that the PC field shall be ignored for the processing of surveillance and Comm A interrogations containing DI=3</p> <p>Action: Meeting to clarify this inconsistency which could result in different implementations (option 1: only PC≠1 shall be ignored see DI=3 WP option 2: consistent no PC if DI=3 – it implies modifying text and figure)</p>	<p>SC209/WG49 deferred to next meeting as issues are being dealt with for DI=3 by Tom Pagano and Eric Potier</p>
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This issue has been presented to the ICAO ASP WG who has accepted the principle to authorized the non-selective lockout using PC=1 when using the DI=3 format (SI code format). Therefore the transponder MOPS can be modified to accept PC=1 as a non-selective lockout when using the DI=3 format.

5.5.8.13	<p>a. Transponder Not Locked Out to All-Calls</p>	<p>Definition of PR checking intervals is statistically wrong. The lower the required reply probability the higher is the chance for a wrong result with 100 interrogations only. The min-max-intervals could be maintained only by increasing the number of interrogations. Please refer to chapter 3 of this document.</p>	<p>Proposed action: Improvement to be considered by the meeting (see Appendix A justifying the changes)</p>	<p>SC209/WG49 asks Mfg to review this and provide feedback</p> <p>MIT LL asked to review and comment on this, as at least one Mfg requested.</p>
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See WP12-07